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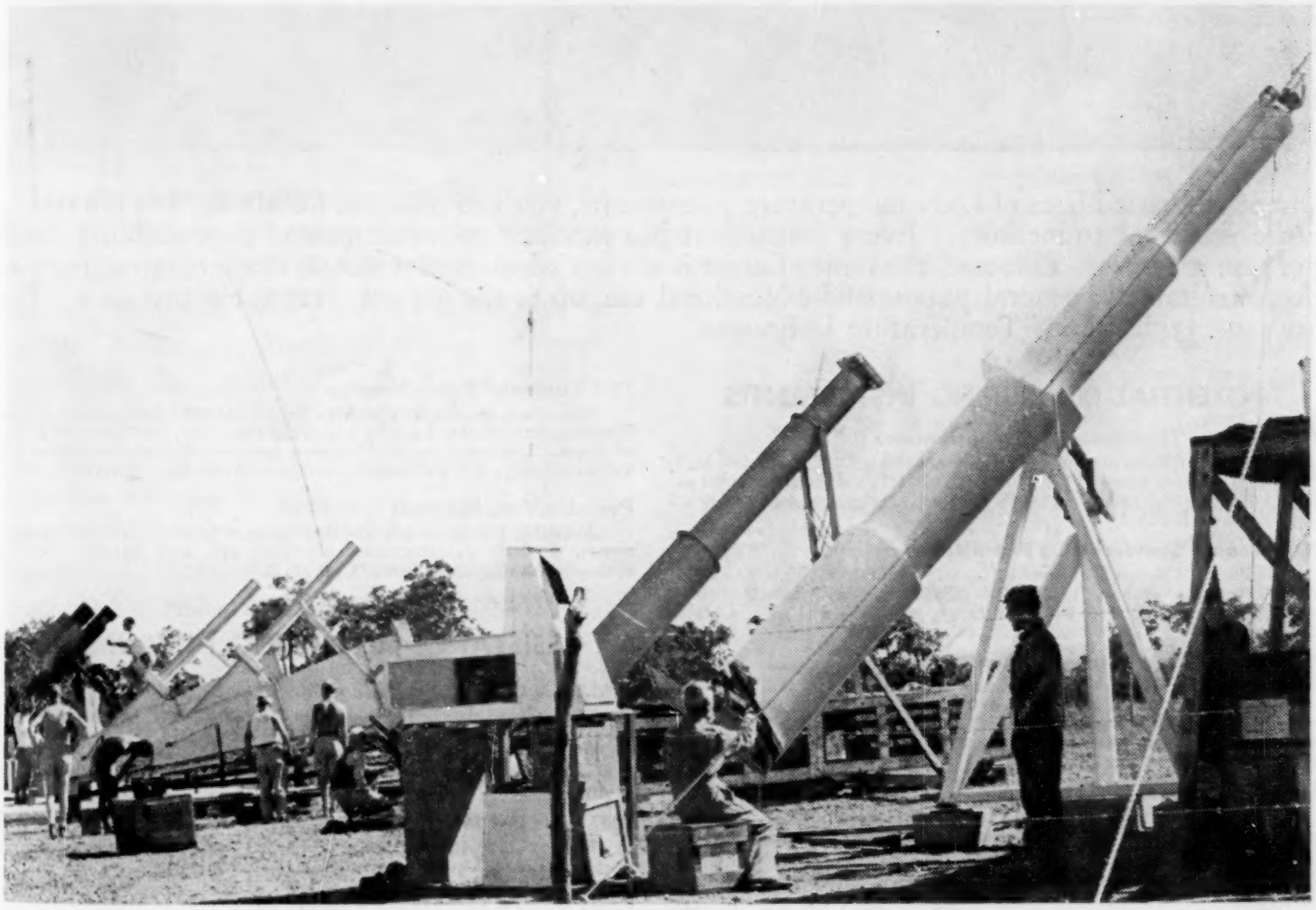

Telescopic cameras of the U. S. Army Air Forces-National Geographic Society Eclipse Expedition being prepared for use during the total eclipse of the sun at Bocayuva, Brazil, May 20. The camera at the right was devised by Dr. George Van Biesbroeck (seated), of the Yerkes Observatory, to determine the Einstein shift.

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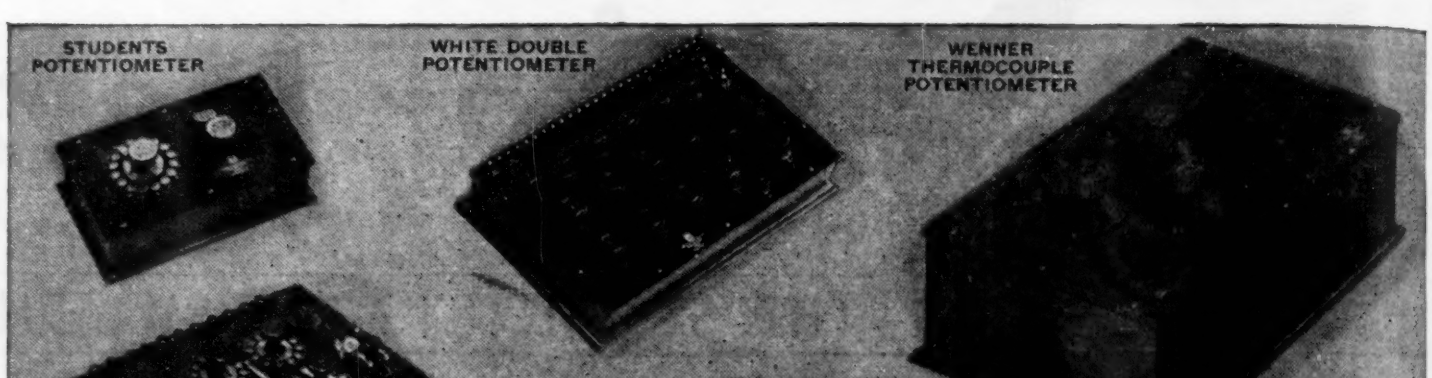
Chromosome Structure Under the Electron Microscope

J. T. Buchholz

A Quick Look At Some L&N Instruments For Measuring Lab Temperatures



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(Cover photo by the National Geographic Society.)

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Chromosome Structure Under the Electron Microscope

J. T. Buchholz

Department of Botany, University of Illinois, Urbana

OUR PRESENT KNOWLEDGE OF chromosome structure, based entirely upon light microscopy, has revealed that the basic structure of the chromosome is a long, slender thread of granules or chromomeres. These chromonemal threads are wound or coiled compactly in forming the chromosome of midmitosis. It is in the prophase of mitosis, before they have become closely coiled, that the individual chromonemal threads may be observed to best advantage. In a critical review with a bibliography of more than 700 titles, Geitler (*5*) has brought together extensive literature bearing on chromosome structure.

Since it has long been recognized that the structure of chromatin is most clearly observable in the early prophase of mitosis, anyone would plan to attack this problem in prophase. The researches of McClintock (*7*) on meiotic prophase chromosomes have, in fact, demonstrated directly that in the hereditary mechanism we are concerned with a linear order of visible particles or chromomeres united in some way into a thread. She has shown that definite sections of these pachytene chromonemas may, by their manner of synaptic approximation, be related to peculiarities in the genetic constitution of the plant. This was probably the closest demonstration by direct observation of the essential correctness of Morgan's theory of the linear arrangement of genes on chromosomes that had appeared up to the discovery and interpretation of giant salivary chromosomes, independently by Painter (*8*) in *Drosophila* and by Heitz and Bauer (*6*) in *Bibio*. Salivary chromosomes have also confirmed the linear arrangement of genes and led to a better understanding of the nature of the genic elements.

The limit of resolution in light microscopy was approached before the turn of the century with the perfection of modern lens systems. Improvement since Abbe computed the lens formulas that are still in use may be expected to result only from greater precision or perfection of workmanship in manufacture. Theoretically, one should be able to distinguish two objects when separated by about 1/5 μ or more—an optical perfection usually not realized. The employment of light of short wave length and ultraviolet improves resolution above this, but the use of ultraviolet depends upon photographic images rather than direct visual methods. The electron microscope gives, theoretically, 100 times better resolution than microscopes dependent upon light; it would separate points that are 1/100 of these distances apart and should therefore give much clearer definition.

Some of the conditions necessary for the examination of objects with an electron microscope are very discouraging to biologists. The objects to be examined must be placed in a very high vacuum and cannot be observed while immersed in fluid media. They are unavoidably subjected to extreme desiccation. Wyckoff (*12*) has recently given an account of the special requirements in preparations examined with the electron microscope. These conditions would not arouse much enthusiasm on the part of cytologists.

Images of dried objects, when examined under light microscopy, appear very unfamiliar and are frequently not recognized as identical when compared with the image of the same object while immersed in water, oil, or other fluid media. Bacteriologists dry the suspensions of bacteria on slides as a routine procedure before and after staining them, but during examination these are usually immersed in oil or other fluid medium of high refractive index. However, biologists must become accustomed to a study of the dried remains of organic matter and learn to employ techniques that differ radically from routine methods.

In using the electron microscope, preparations of objects may be carried out under light microscopy. Hence, one must learn to recognize selected objects in both conditions (immersed in fluid as well as dry), even when the dry object shows much less detail and appears very different from the customary mount.

Since the installation of an electron microscope at the University of Illinois in 1942 it has been the writer's ambition to render service in adapting this equipment to the study of chromosomes. Sporadic efforts made to mount and observe prophase chromosomes failed completely, but such efforts serve to familiarize one with the general technique and requirements in selection of objects suitable for study. It was soon realized that very special techniques must first be developed. For long periods all efforts other than reflection and speculation were abandoned. The present period of intensive experimentation began in June 1946.

Schmitt's claim (*11*) that sections of organic tissue must be cut as thin as 0.1 μ or less in order to be sufficiently penetrated by electrons to form images may be an overstatement, but he did not specify degree of magnification and definition. Claude and Fullam (*4*) have actually obtained electron micrographs from sections 0.3–0.6 μ in thickness but under magnifications not greatly exceeding those attainable with light microscopy. Their photographs, made at initial magnifications of 1,650, demonstrate that electronically recorded images actually show

much greater resolution than those of photomicrography and that they are subject to considerable enlargement. However, sections of more highly magnified organic objects should be made much thinner than has been attainable thus far.

Porter, Claude, and Fullam (*9*) have given electron micrographs of parts of entire cells obtained from tissue cultures—cells derived from chick embryos. Due to their thickness, these were photographed at magnifications of 900–1,600 and enlarged to ×15,000. In the photographs the superior resolving power of the electron microscope is evident by the sharp contrast and definition of the images. Only resting interphase nuclei were included. In regions of nuclei these isolated cells were too thick to show structure. As far as the writer has been able to find, chromosomal structure has not been certainly demonstrated with the electron microscope.

Some preliminary results on "lampbrush chromosomes" had been reported from our laboratories by Clark, Barnes, and Baylor (*2*) and illustrated in Clark, Quaife, and Baylor (*3*). Interpretations of these results have been complicated through subsequent investigations by Quaife (*10*) on protein salt systems, and some of these investigations remain incomplete and unpublished.

It occurred to the writer that the difficulty of obtaining small, thin objects might be overcome by teasing parts from cells. This is essentially the general method employed by Schmitt (*11*) in the study of muscle and collagen fibers. However, this technique involves new difficulties when used in a study of cells. Cytologists will realize at once that a thread stained with hematoxylin and located within the nuclear membrane is usually interpreted as part of a chromosome; similar objects encountered in cytoplasm outside of the nuclear membrane might be interpreted as mitochondria, chromidia, etc. When a cell is torn open and dismembered, how can one be certain as to the origin of the residues? Even when the cell has been stained, the chromosomes are not the only objects that may possess color.

Some of these difficulties have been overcome. It was found possible to recognize parts of chromosomes in prophase after they were desiccated on a slide. Through repeated rehearsal of dissection methods it was possible to isolate parts of chromosomes and separate them completely from the surrounding cytoplasm. Parts of prophase chromosomes from the pollen mother cells of maize could be isolated by operating on individual cells that had been transferred to clean slides. Furthermore, a technique has been developed by which an object such as an isolated bit of chromosome, definitely recognized as coming from within the nucleus, may be dried, mounted in a film, and transferred to the object holder of an electron microscope. The selected object is carefully centered when mounted or so related to peculiarities of the mount that its position may be recognized in the finder of the microscope. There is still some lack of perfection in this technique, which may be responsible for the considerable loss in contrast and definition thus far obtained from these objects at the magnifications used. An account of the technique will be given in detail in another publication. It is from such isolated bits of prophase chromosomes that the accompanying electron micrographs were obtained.

While the writer has dissected and prepared all objects and selected the images to be photographed, he does not operate the electron microscope by himself.[1] Another microscope, a new Universal model, was used in one session on January 2, 1947, at the Battelle Memorial Institute, Columbus, Ohio.[2] This new model gave excellent results and seems ideally adapted for biological investigations such as these. With more patience, equally good and some superior electron micrographs were obtained with the older RCA model (Serial No. 1) installed in G. L. Clark's laboratory at the University of Illinois. Even though this microscope is capable of higher magnifications, nearly all of this work was done at initial enlargements of 10,000–12,000. There are now more than 50 negatives showing chromosome structure in maize.

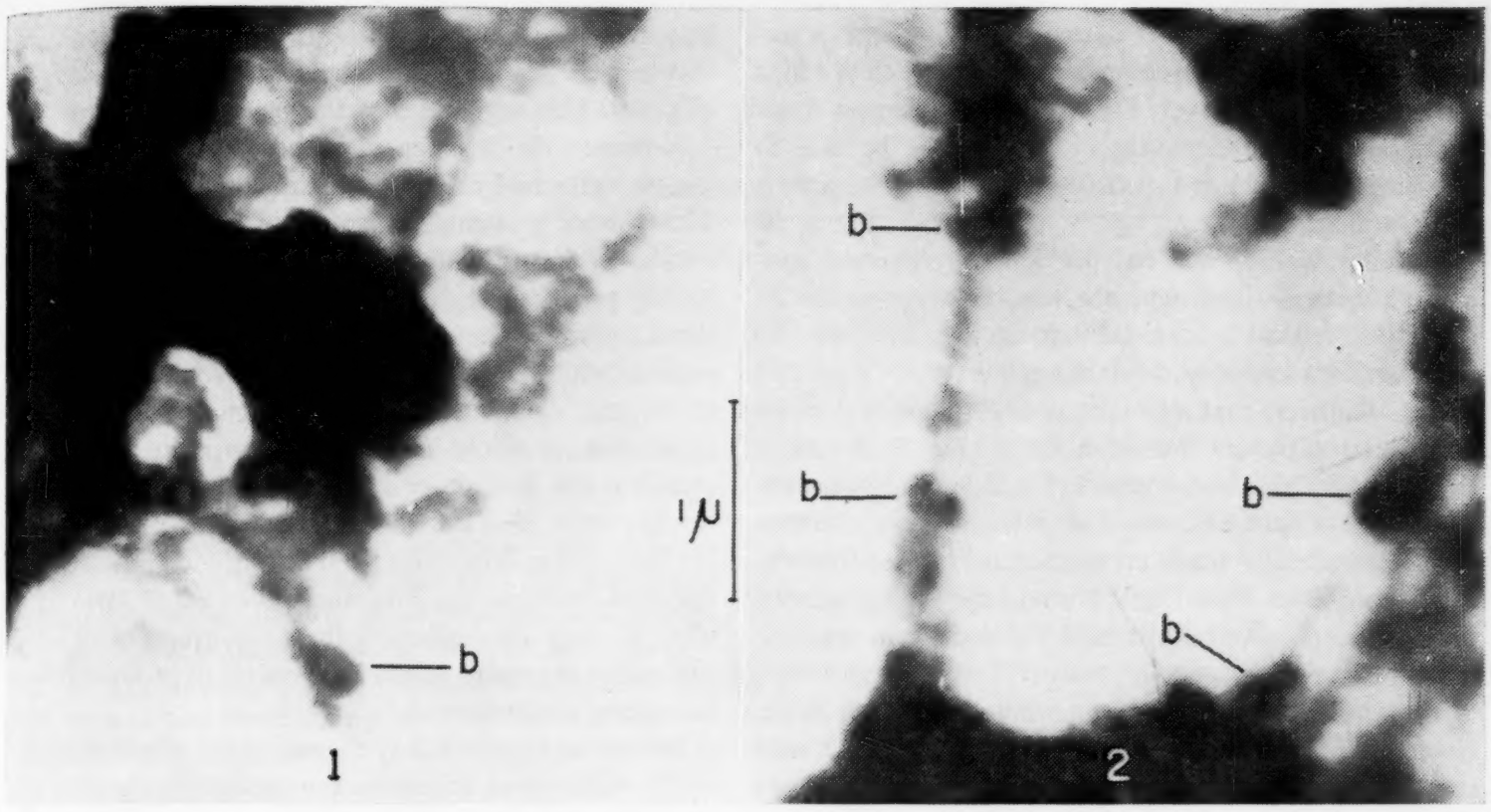
The picture of chromosome structure obtained has not greatly altered the general concept derived from light microscopy. There is close agreement with previously known features. Some details only partially known may be ascertained, and the method gives promise of supplying information concerning many other unknown or little known facts.

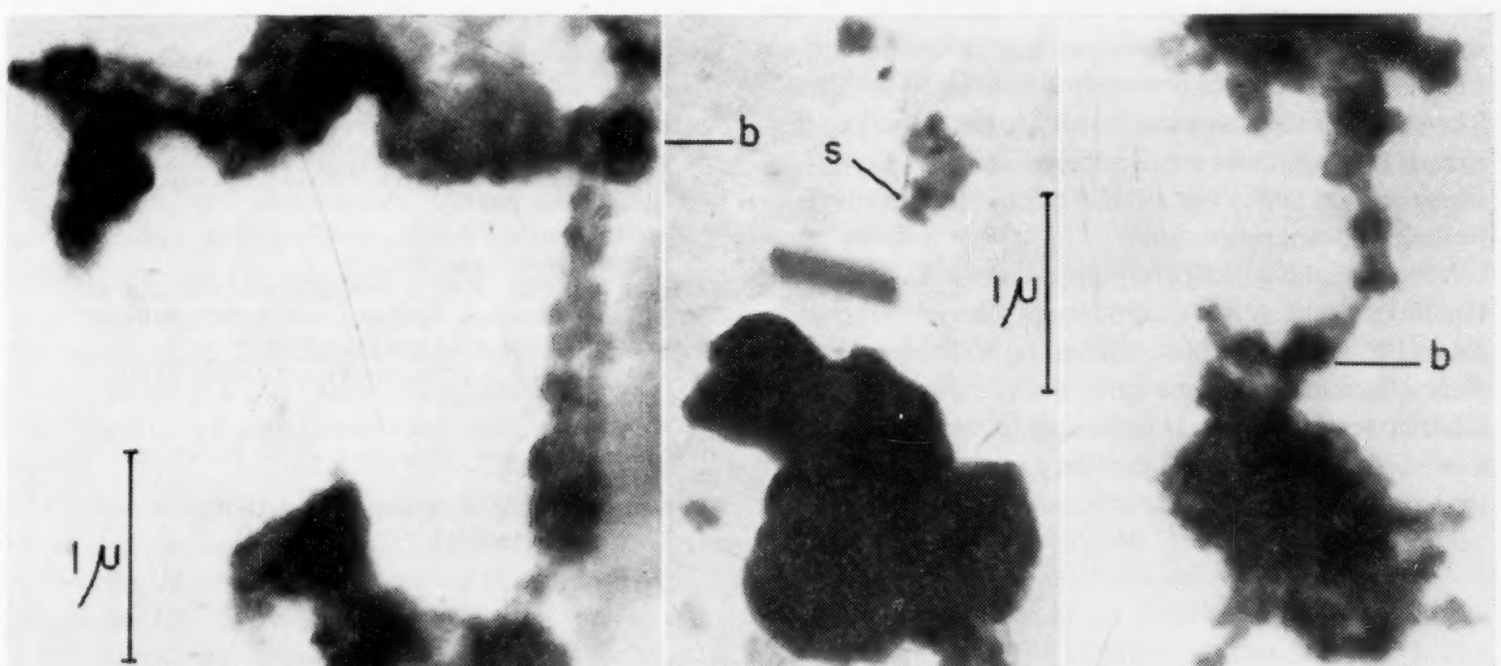
There is a thread that connects the granules or chromosomes or to which a great variety of chromomeres are attached. In places this thread appears to be flattened, and granules appear to be attached laterally. Both its width and thickness may not be constant. Some regions would indicate a width of 100 mμ or more in places that may border heterochromatic regions. The smallest values estimated for width were 50, and the smallest for thickness were about 30 mμ. Granules were usually found attached in pairs at the rate of 4–5/μ. In regions in which they were most crowded there were as many as 8/μ along the length of the thread. In some regions there were relatively few granules, but one cannot be certain that some of these may not have become detached and washed away during dissection and mounting. Data such as these, when given with greater precision, may be useful in estimating the actual size of the smallest visible elements of the gene.

The chromomeres or granules that are found attached to the supporting thread vary through a wide range of sizes, shapes, and "density." Some are spherical and relatively translucent to electrons and range in size from 75 to 165 mμ. The spherical translucent granules are observ-

[1] The writer is greatly indebted to A. Eisenstark, who is employed by the Graduate School of the University of Illinois to operate this equipment for biological departments; to Martha B. Baylor, who was in charge of the electron microscope prior to September 1, 1946; and to H. B. Gillin who substituted for Mrs. Baylor on several occasions.

[2] This was made available through the courtesy of the Institute and Charles M. Schwartz, who operated the equipment.





FIGS. 1–5. Electron micrographs of fragments of chromosomes at or near pachytene, dissected from pollen mother cells of maize. All figures are × 20,000, enlarged from original recording made at × 11,000, except Fig. 4, which was recorded at × 12,000, and reproduced here at × 26,000. The granules are shown attached to a "linin" thread and vary greatly in size, shape, and "transparency" to electrons. Those shown at b scatter the electrons and appear as if "opaque". Those shown at s are spool shaped. Fig. 5 shows a long thread in snarls which appear as chromomeres under light microscopy.

able in all except Fig. 4. The spherical and spheroidal granules that appear as if opaque to electrons (Figs. 1–3, b) range in size from 85 to 660 mμ. Spheroidal "dark" granules were seen that may be estimated at 150 x 180, 132 x 220, 210 x 330, and 330 x 430 mμ.

Very many other granules seem to be lobed bodies—possibly spool shaped. Some of these may be seen in Fig. 4 near the s markers. When symmetrically lobed, these suggest the possibility that they are granules in stages of division, which could also apply if they are actually more nearly spool shaped. In some regions these measure approximately 150 x 210 mμ; others were estimated at 130 x 165 mμ.

Synapsis may be observed in some of the chromonemal

threads where they appear paired. Fig. 3–4 shows a section of two synapsed chromonemal threads, each of which may be double. However, Figs. 1, 3, and 5 suggest single threads, the double nature of which may be due to doubling of the chromonema itself, giving sister strands as in ordinary mitosis.

Nothing decisive and not previously recognized concerning synapsis is shown, nor would interpretation be considered critical in material that has been subjected to considerable manipulation in dissection.

Not all objects that may appear as chromomeres under light microscopy are individual units. Fig. 5 illustrates this, for here the bodies about 1 x 2 μ in size that are visible under light and would be interpreted as chromomeres are actually made up of snarls of beaded threads. Similar snarls in Figs. 1 and 2 would appear as rounded beads when observed under light microscopy so near the limits of resolution.

The granules that appear smooth and spherical in the electron micrographs may represent homogeneous substance, made up of uniform molecules. This might suggest that we are now actually dealing with the genic elements, with only the individual molecules of these units remaining unrevealed.

But where is the gene? Unfortunately, the answer may not be given with assurance. If the granules are considered as the genes, then these units are not uniform in size and shape. Granules may be found among those that appear to be homogeneous that range in size from 50 to 750 mμ. They vary also in shape and density to electronic penetration. If these granules are considered as initial products of the gene, one might more easily appreciate the diversity in their appearance.

The gene of genetic interpretations may, however, represent sections of chromonemal threads, including several kinds of granules. The work of Bridges (*1*) has shown, in fact, that some genes are composed of several alternations of dark and light bands in the salivary chromosomes of *Drosophila*. A corollary to this would suggest that numerous unlike granules may be included in the gene referred to by geneticists. It would appear logical to consider the granules shown here as parts of the elements of genes. This suggests that the gene is composite.

However, the chromonemal threads to which the granules are attached cannot be excluded from this concept. This thread is a vital part of the living substance that divides during the mitotic cycle, and if the granules are visible products of molecules, incorporated within the thread to which they appear attached, then we should not exclude, while they remain attached, these granules as parts of the genic elements. In a somewhat different sense the genic element would therefore be composite, even if one considers the position of a granule as its locus. This unit would consist of at least one molecule within the supporting thread that duplicates itself during each mitotic cycle and also produces the substance given off to form granules. It may be presumed that the granules or their derivative substance would be given off to produce effects elsewhere within the cell.

It may be expected that the use of the electron microscope will reveal much in the study of chromosome structure. In any event, it would seem that a concept of gene elements should emerge from a continued study of chromosomal structure by this means.

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The First Pan-African Congress on Prehistory

Wendell Phillips

Museum of Paleontology, University of California, Berkeley

THE FIRST PAN-AFRICAN CONGRESS ON Prehistory was formally opened in the Town Hall of Nairobi on January 14, 1947, by the Governor of Kenya, Sir Philip Mitchell.

Speaking in French, Prof. L'Abbé Breuil replied in part as follows:

It is barely a century ago that English and French scientists including inspired men like John Frere and Boucher de Perthes, soon to be helped by those grandfathers of geology, Lyell and Prestwich, and by biologists like Darwin and Huxley, discovered that humanity went back to times far more remote than those of man's ancient history. Both in this organic development and in this material civilization, the species to which we belong has taken innumerable aeons to reach the present Parnassus of spirit, leaving behind forms today extinct, while passing through a series of glacial and interglacial ages. The importance of this discovery in the story of man's history equals the discoveries of Copernicus and Galileo in the field of astronomy. Our old nations are now becoming grandfathers, and we, the workers of yesterday, must realize that from the Nile to Cape Town and in Kenya which is like the very heart of this continent our work is developing beyond all hopes.

Following addresses by several other delegates the Abbé Breuil was unanimously elected president and Robert Broom, vice-president, of the Congress.

All of the scientific papers and discussions of the Congress were encompassed in three sections: Prehistoric Archeology, L. S. B. Leakey (chairman); Human Paleontology, Raymond Dart (chairman); and Geology, General Paleontology, and Climatology, Alex du Toit (chairman).

The Congress was conceived, organized, and directed in all of its aspects by L. S. B. Leakey, curator of the Coryendon Museum, whose untiring efforts were largely responsible for its great success.

An interesting feature of the Congress was that, of the 55 official delegates representing 26 different countries, 25 were not prehistorians: 5 were paleontologists; 5, anatomists; and 15, geologists. Those in attendance agreed on the importance of this collaboration from a group of specialists in different fields of science who could bring their specialized knowledge and mutual interest to bear on the problems of research in prehistory.

Although the main theme was prehistory, the organizing secretary wisely broadened the scope of the discussions to include such relevant subjects as climatic changes, pluvials, and glacials in relation to prehistory; Quaternary geology in relation to prehistory; and those aspects of paleontology which intimately concern prehistory, such as the use of fossils for dating deposits and the question of African ape remains and their relation to the problem of the origin of man.

As a member of the Subcommittee on Human Paleontology my interest was focused mainly on the fossil, australopithecine man apes from South Africa, and the lower Miocene primates from Kenya. Following Prof. Dart's epoch-making discovery of the Taungs child in 1924, it remained for the genius of Robert Broom to unfold new types of *Australopithecus*.

At the close of the Congress Dr. Broom took me to the Kromdraai and Sterkfontein deposits. These have one important feature in common: all the fossils recovered from them, including the types of *Plesianthropus* and *Paranthropus*, were in travertine breccia in old limestone caves which have so far revealed no traces of fire and artifacts. A possible exception to this may be the Cave of the Hearths in Makapan Valley, where C. van Reit Lowe has discovered hand axes in a bone breccia with an associated fauna similar to Sterkfontein and Kromdraai. Further work is required in this region to ascertain whether or not australopithecines are present.

At the Congress Le Gros Clark presented a summary of the important intermediate characters of these man apes which was strongly reminiscent of the prior conclusions of W. K. Gregory and Milo Helman, who studied these forms during their South African visit in 1938. If Dr. Broom is correct in placing the australopithecine forms in the early Pleistocene or even the late Pliocene, this might exclude them from the direct ancestral stock of the Hominidae. This does not remove them from a position of prime importance, however, for they are regarded by many as slightly modified survivals of the ancestral stock from which man arose.

Recent discoveries of lower Miocene primates by L. S. B. Leakey and D. G. MacInnes at Rusinga Island in Lake Victoria are of great interest. The new find of an almost complete jaw of *Proconsul* shows characteristics which point to a close relationship with the dryopithecine apes of Europe and India.

Although *Proconsul* may not be on the human line, it has a number of characteristics which suggest man as well as the simian forms. Thus, *Proconsul*, with the recent associated discoveries of the jaws and teeth of *Limnopithecus*, which may be an early member of the gibbon group, and *Xenopithecus*, which probably belongs to the same stem as the orangutan, helps to bridge the great gap between the Fayum of Egypt, where we find

Propliopithecus and *Parapithecus* in the Oligocene, to the dryopithecine apes of the upper and lower Pliocene and Miocene of Europe and India.

The first formal resolution of the Congress was that the continuity of the work should be insured by holding such a congress every four years. This brought about an immediate invitation from Field Marshal Smuts to hold the next meeting in the Union in 1951.

Confusion which has arisen in attempting to date events in Africa has been due largely to the fact that European Pleistocene stages have been applied to Africa. These are not suitable because of the great difference in conditions in Africa and Europe. Thus, a resolution was passed that European terms for that portion of the geological record which covers the period of man's development in Africa should be dropped and that a purely African nomenclature based on the stratigraphic sequences in Africa, should be employed.

A permanent consultative committee was established at the close of the Congress to advise on the use and application of terms to describe the different ages and stone cultures in Africa. This committee has five members, South Africa, East Africa, West and Central Africa, Northeast Africa, and Northwest Africa and the Sahara, each being represented by one member. African terminology has always been difficult for foreign students, and the creation of this new committee will contribute to a better understanding by eliminating ambiguous names.

Finally, a number of resolutions were passed which are to be submitted to the governments of the various African territories where prehistory has not yet been officially recognized and where it is hoped archaeological surveys will be established along the lines of those in Egypt and the Union.

To many of the delegates the excursions undertaken during their stay in East Africa were of even greater interest than the meetings. The first of these was made to the Great Rift Valley, where the delegates visited the controversial Cartwright site containing the cultural remains called Pseudo-Stillbay; the Kariandusi site, developed as a "museum on the spot," where an Acheulean living site has been preserved; and the Enderit Drift, which includes the type section of the Makalian wet phases. A visit was then made to Gambles Cave on the Mau escarpment, which is the type section for the upper Kenya Aurignacian cultures and where remains of Aurignacian man had been found. The third trip took us to the scene of the spectacular discoveries at Olorgesaillie. Here, some 43 miles from Nairobi, on the road between Lake Magadi and the extinct volcano, Suswa, Mrs. Mary Leakey in 1942 discovered, scattered over the erosion slopes below a cliff of ancient lake beds, literally hundreds of perfect hand axes and cleavers which were being washed out from a series of old land surfaces interbedded in Pleistocene lacustrine deposits. Trial trenches had been cut, uncovering the actual living floors of the Acheulean hunters. These beds were formed in a fluctuating lake and between each successive rise Acheulean man camped on the shore close to the water.

At least 10 ancient camp sites, each covered in turn by the periodic flooding of the area, have been discovered. In direct association with the hand axes and cleavers, there are numerous fossilized remains of the extinct giant baboon (*Simopithecus*); the straight-tusked elephant (*Elephas antiquus*); and giant pigs and horses, all with the majority of their bones split open for purposes of marrow extraction and with the skulls broken in order to obtain the brains.

A protective shelter has been constructed over each excavated site. Kenya, with a white population numbering only a few thousand, is far ahead of most countries in the development of such unique educational features. On this excursion, the Olorgesaillie Museum was formally opened to the public by Sir Gilbert Rennie, Chief Secretary of Kenya.

The second excursion was made to the prehistoric obsidian mines in the Njorowa Gorge, south of Lake Naivasha, which had once been the overflow channel of a large lake. After the lake had dried up and the channel had been abandoned, Stone Age man discovered an exposure of particularly fine obsidian, ideally suited for making tools. Many tons were mined with primitive stone implements, resulting in a tunnel through a hundred feet of solid rock.

The delegates assembled on January 24, 1947, for the final excursion, which took them over nearly 1,000 miles of southern Kenya and Tanganyika. One of the sites visited was Olduvai Gorge, where, over a distance of some 30 miles, there is an exposure of 300 feet of stratified human history contained in the numerous layers of lake sediments in both sides of the canyon. The total length of the exposure is over 135 miles. Of the five major deposits at Olduvai, the first four belong to the Kamasian Pluvial. In East Africa there are two major pluvials—the Kamasian and the Gamblian—followed by two minor wet phases, the Makalian and the Nakura. The lower part of the Kamasian is regarded as lower Pleistocene and the upper part as middle Pleistocene, while the Gamblian Pluvial represents the last third of the Pleistocene.

Bed I contains a fauna which includes *Dinotherium*, *Chalicotherium*, *Sivatherium*, and true elephants. Associated with the Oldavian Culture, there is a rapid evolution of the stone hammer technique which is continued through the 40-foot deposits of Bed III. Between Beds III and IV there occurs a 10-foot gravel band containing fine ovates with an "S" twist. Bed IV is the equivalent to Olorgesaillie and has a faunal assemblage containing many antelopes, as well as Hipparion, which is found throughout Kamasian Beds I–IV. Bed V is unconformable to the whole series.

In Serenje Hills the delegates were given an opportunity to study the cave paintings at Kisese Giraffe Shelter, Kisese Main Shelter, and the Cheke Rock Shelter. These paintings, preserved by penetration of the color through the rock, were superimposed, each period being revealed by its own distinctive style. According to the Abbé Breuil, the splendid line drawings of rhinoceroses giraffes, ostriches, and elephants were apparently related to paintings in European caves of an earlier period. Human figures with large, round heads and with bodies and limbs elongated out of all proportion, although not as artistic, demonstrated excellent movement in hunting scenes. The Abbé Breuil believes that the Tanganyika art is earlier than a large part of the Rhodesian and Southwest and Southeast African paintings and perhaps provides a key to the origin of art in other parts of the continent.

The collaboration of anatomists, paleontologists, and geologists with the prehistorians and the development of harmony and understanding between men in various scientific fields and of different nationalities seemed to be the most important single achievement of the Congress. The majority of delegates were sympathetic toward Darwin's view that Africa was the probable cradle of man. Whether or not this view is correct, within Africa there are still great possibilities for far-reaching contributions to the study of man's beginnings.

Obituary

Wilhelm Caspari
1872–1944

Wilhelm Caspari, for many years head of the Cancer Department of the Institute for Experimental Therapy Frankfurt am Main, Germany, died in 1944 in a ghetto concentration camp at Lodz, Poland. While there, he was conducted to give medical aid daily under guard to a German Army Hospital for infectious diseases and returned nightly to the ghetto. He died shortly before the liberation of Lodz by the Russians. His wife, exiled with him, was taken from the camp in 1942 and since then has not been heard of, in spite of extended searches made by the Joint Refugee Committee. A tragic feature was that Prof. Caspari's oldest son, who had been in this country since 1938, had obtained, in 1941, an American visa and funds for his parents. The visa arrived at the American Consulate in Frankfurt only two days after the Nazi deportation to Poland.

Prof. Caspari was born February 4, 1872, in Berlin, where his family had been established for generations. He studied chemistry and medicine at the Universities of Freiburg and Berlin and obtained his Doctor's degree at Leipzig in 1895. He joined the Department of Physiology, then under the direction of Nathan Zuntz, at the Royal Agricultural College, Berlin, where he remained until 1914. He served as a surgeon at the Western Front and, after the war, was engaged in rehabilitation of the wounded and invalids. In 1920 he succeeded L. Apolant at Frankfurt, remaining there in charge of the Department of Cancer until his dismissal in 1936 by the Nazi administration under the Nuremberg decrees.

As one of the pioneers of vitamin research, Caspari was early engaged in the metabolism of nutrition. He took part in Zuntz's expedition to Monte Rose for the purpose of investigating the influence of mountain climate on metabolism and participated in the classic, scientific reports of this undertaking. Later he became interested in the action of radiation on cell metabolism and growth—in particular, on cancer. With Emil Aschkinass he investigated the effects of X-rays on bacteria and was the first to apply radioactive material to the treatment of cancer. At Frankfurt, he worked on immunity, on resistance against cancer, on the effects of catabolic products of the necrotic part of tumors and of other dead or injured cell material, and on the influence of outside agents such as irradiation. His approach to the cancer problem was that of the physiologist, e.g. his studies on the influence of hormones and of nutrition on tumor growth. His experiments on the action of tumoraffine heavy metal salts on tumors, undertaken with Neuberg and Loehe, were interrupted by World War II.

In addition to the multitude of his published reports on experiments carried out by himself and his many fellow workers, he contributed to handbooks of physiology, cancer research and radiation. For many years he served on the council of the German Cancer Committee. He was an honorary Ph.D. of the University of Frankfurt, a corresponding member of the National Academy of Medicine of Spain, of the British Empire Cancer Campaign, and of the Physico-Medical Academy, Florence, Italy.

ERNEST SCHWARTZ
U. S. National Museum, Washington, D. C.

ROBERT CHAMBERS
Department of Biology, New York University

Willis Linn Jepson

1867–1946

Willis Linn Jepson, dean of California botanists, died at his home in Berkeley on November 7, 1946, after a protracted illness, at the age of 79. He devoted a fruitful half century of zealous investigation to the systematic botany of his native state. His *Flora of Western Middle California* (1901), *Silva of California* (1910), *Manual of the flowering plants of California* (1923–25), and the monographic (uncompleted) *Flora of California* (1909–43) have firmly established him not only as the principal interpreter of the California flora but also as one of the greatest of American regional botanists. "Jepson's Manual" has been for more than 20 years the well-worn threshold for thousands of students to an understanding and appreciation of the remarkably diversified vegetation of the state.

Jepson was born of Scotch-English stock on August 19, 1867, at Little Oak, near Vacaville, in the rolling foothills at the edge of the Great Valley. He was graduated from the University of California in 1889. The following year he became an assistant in botany and devoted his attention principally to systematic botany under the direction E. L. Greene, pioneer taxonomist and founder of the Department of Botany. From 1895 to 1898 Jepson served as instructor, undertaking research with Greene, M. A. Howe, Setchell, and J. C. Merriam at Berkeley, G. F. Atkinson and W. W. Rowlee at Cornell (1895), and B. L. Robinson at Harvard (1896–97). He was awarded the Ph.D. at the University of California in 1899, with a major in systematic botany and minors in plant physiology and paleophytology. In 1905 he studied the classical herbaria at the Royal Botanic Gardens, Kew, and in 1906 those at Berlin. He was made assistant professor in 1899, associate professor in 1911, professor in 1918, and professor emeritus in 1937. Thus, his entire life was identified with the University, and his work devoted almost exclusively to the plants of California.

His botanical reputation must rest primarily on the ambitious *Flora of California*, which he regarded as his major contribution. This is perhaps the outstanding work on regional flora thus far produced in this country. It owes its great merit to the wealth of field observation, ecological and geographical data, profuse illustration, and careful documentation of observations and ranges by citation of specimens, as well as to the eminently sane taxonomic judgment. Although he was a student and admirer of Greene and incorporated much of that author's brilliant but frequently erratic work, Jepson's taxonomic concept was essentially conservative and in the tradition of Bentham, Hooker, Torrey, and Gray. Because of its general usability, his manual has long enjoyed a popularity in the West comparable only to that of "Gray's Manual" in eastern North America. Jepson's voluminous publications will necessarily serve as the basis for all future work on the rich California flora.

The editorship of *Erythea* was turned over to him by Greene, and he served in that capacity from 1893 to 1900. Jepson founded the California Botanical Society in 1915 as well as its journal, *Madroño*, which he edited until 1933. In these two journals appeared most of his shorter papers, dealing with botanical exploration and biography, geographical distribution, taxonomy, and teratology. His field work covered most of the state, and he was particularly fond of the less known deserts, mountains, and valleys, where he reveled in the role of pioneer explorer. In 1899 he made a botanical expedition to Alaska, and in 1926 to Syria and Palestine, but the bulk of his field study was confined to California. He was an enthusiastic conservationist and served as a councilor of the Save the Redwoods League and of the Point Lobos Association. Although he will be classified as an "orthodox" taxonomist, he was an ardent evolutionist and more hospitable than many of his contemporaries to the cytogenetic and experimental approaches of "biosystematics."

Many honors came to him during his long, productive lifetime. His colleagues honored him with the Faculty Research Lecturership in 1934, and his University with the LL.D. in 1941. He was president of the California Botanical Society, 1913–15 and 1918–29; fellow of the California Academy of Sciences, American Academy of Arts and Science (Boston), Royal Society of Arts (London), and American Geographical Society; delegate to the International Agricultural Congress at Liége (1906) and the International Botanical Congresses at Cambridge (1930) and Amsterdam (1935); foreign member of the Société Linnéenne de Lyon and the National Botanical Society of Czechoslovakia; councilor of the Rancho Santa Ana Botanical Garden; life member of the American Genetic Association; and member of the American Society of Plant Taxonomists, Botanical Society of America, Society of Foresters, Washington Academy of Sciences, Western Society of Naturalists, Phi Beta Kappa, and Sigma Xi.

His memory is perpetuated by the saxifragaceous genus, *Jepsonia*, dedicated to him by J. K. Small, and by a host of commemorative specific epithets. But these tokens are insignificant in comparison with the tremendous debt owed him by every student of Californian natural history. He was remarkably successful both as teacher and writer in communicating his great enthusiasm for the flora which he had done so much to make understandable. Perhaps he would prefer to be remembered, in the words of his memorial to Parish, "as one who cared for and gave his life without stint to botanical science, as one who believed in the science absolutely, as he conceived it."

LINCOLN CONSTANCE
University of California, Berkeley

NEWS *and Notes*

The secretaries of all societies planning to participate in the Chicago meeting of the AAAS next December have been sent a letter in which financial problems of the Association and its affiliated societies are outlined. It is estimated that the total expense of the meeting will be about $35,000 and the net deficit about $14,000, $7,000 of which will result from session room charges levied against the AAAS for the first time by the Chicago hotels. In the past deficits have been paid from AAAS reserves, but the Association no longer has these reserves. Consequently, it was requested that the executive committee of each cooperating society pass a resolution that, when meeting with the AAAS, attendance at sessions be restricted to those registering with the Association.

A number of facts concerning the financing of the AAAS meetings were pointed out: that the affiliated and associated societies do not contribute to the financial support of the Association in any way; that fewer than half of the persons who attend the meetings register, and most of those who register are AAAS members; and that local committees for meetings assume financial burdens of $4,000–$5,000 and contribute nearly as much again from their time.

Quoting further from the letter, "While one of the major aims of the AAAS is to facilitate cooperation among scientists, as it does through its meetings, the dues of 35,000 public-spirited members scarcely meet the present costs of operation and publishing its journals, let alone the needs of nonmember participants. . . . The payment of a registration fee of $2.00 or $3.00 represents only a small fraction of the total expenses of the average individual attending a convention, and it does not seem unreasonable to expect that meeting expenses be paid in part on a pro rata basis by those who benefit from the convention. If publication of the *General program* were the only service provided by the Association and the local committees, it would not be reasonable to ask members of societies that publish their own programs to register with the AAAS. However, the services are many and, as evidence of appreciation, the cooperative spirit of the local committees might well be reciprocated through the registration of all the conventioners. Both at Boston and Chicago the committee chairmen unanimously recommended that registration be made mandatory in order that the annual convention be placed on a sound financial basis. No other major meeting of scientists has as low a registration fee, and it is difficult to believe that payment of it would work a serious hardship on the members of the cooperating societies."

In a questionnaire the secretaries of those societies which met with the AAAS in Boston were asked if the registration fee should be made mandatory. Of those who replied, over two-thirds said "yes." The problem of increasing registration has been discussed in detail with society secretaries who have visited the Washington office, and all have agreed that general registration is essential to the support of the meetings.

The reactions to the letter were not as varied as anticipated, there being an almost unanimous expression favoring the registration of all conventioners. Typically some of the comments are as follows:

"I personally believe that: (1) registration should be required for attendance at any of the activities or meetings of the Association or affiliated societies; (2) the registration fee for nonmembers should be $8.00; and (3) that a nonmember, by joining the society, may register at the regular fee for members, namely, $5.00."

"Your moving letter of May 21 on Annual Meeting costs and registration fees has been carefully read. You put the situation in a somewhat different light than I have had and I would now retreat somewhat from my stand of a few months ago. You will remember I wrote you then in an unsympathetic vein about registration fees."

"In addition to a registration fee, a fee (should) be charged for the reception and for all smokers. . . . scientific sessions (should) be proctored and no one admitted who does not show evidence of having registered."

"I have at hand your memo of May 21st to Secretaries of the Societies meeting with the AAAS in Chicago. I think you are perfectly justified in bringing the question of finances to their attention, and I am completely in agreement with any policy of required registration."

"I am unable to understand the attitude of those who deliberately fail to register and at the same time are willing to avail themselves of the advantages of the meetings at the expense of others. I suspect and hope that a good deal of this neglect is due to thoughtlessness and failure to think of the implications of such an attitude. Even so, it is a significant criticism of the supposed capacity of scientists to carry over into the field of social relationships the kind of thinking which is alleged to be implicit in the scientific approach."

"I have your memo relative to expenses of meetings. I think the two dollar registration fee is all right, but I would be opposed to making it any more than this. I know that many people are a little bit restive about having to pay a fee at all, particularly if they only want to go to a couple of sessions. However, I believe it is very necessary and should be followed."

"The headache back of all of the endeavor is the fact that the Association is top heavy with affiliated societies which have their own annual meetings and which are the first love of the members. . . . I am all out for increasing the annual membership fee to $10.00. But I also incline to the view that the annual meeting should be self-liquidating."

". . . it is the unanimous opinion of our Executive Committee that a mandatory registration fee should be charged at all AAAS meetings. A fee of two dollars might cover the costs if the fee is mandatory. If it will not cover the costs, the fee should be increased to three dollars."

So far, not one letter has been received in opposition to general registration. However, legislative machinery is slow moving and, in lieu of a final decision by the various executive committees, the administrative officers of the Association have adopted the following course of action: Each society meeting in the hotels in Chicago will pay the charges for the session rooms it uses. When all the operating costs of the convention have been met by the Association, any surplus from registration will be distributed on a proportional basis among the cooperating societies to help cover the costs assessed them for the use of session rooms.

The AAAS is a federation of scientific societies with no binding ties other than a desire to maintain a centralized organization, representative of all fields of science, that can speak for American science and, through inter-society cooperation, broaden the intellectual horizons of its members. The governing body of this federation is its Council, more than two-thirds of which is elected by the affiliated societies, and which, in turn, elects all general officers of the AAAS, including its Executive Committee. The policies and plans of the administrative officers of the AAAS are, therefore, those determined by the affiliated societies.

About People

Donald F. Jones, chief geneticist, Connecticut Agricultural Experiment Station, received the honorary degree of Doctor of Science from Kansas State College June 1, in recognition of his outstanding work in genetics and his origination of the method by which hybrid seed corn is produced commercially.

Louis N. Ridenour, formerly assistant professor of physics, University of Pennsylvania, has been appointed dean of the Graduate School, University of Illinois. During the war Dr. Ridenour directed the development of new types of radar at the Radiation Laboratory, Massachusetts Institute of Technology, and later served as special consultant to Gen. Carl A. Spaatz.

Colin G. Fink, professor of electrochemistry, Columbia University, has resigned his position as secretary and editor, Electrochemical Society, after 26 years of continuous service. Dr. Fink, now "secretary emeritus," is succeeded by R. M. Burns, chemical director, Bell Telephone Laboratories.

George B. Barbour, dean, College of Liberal Arts, University of Cincinnati, leaves this month for Johannesburg to join the University of California African expedition as geologist and physiographer. The group, under the leadership of Charles L. Camp, director of the Museum of Paleontology, will spend the early part of the field season excavating cave deposits of the type where fossil anthropoids closely related to primitive man have been found.

B. S. Pickett, head, Department of Horticulture, Iowa State College, will spend a year in Syria as horticultural adviser to the Syrian Government. Prof. Pickett, who has been granted a year's leave of absence, expects to plan and begin research work in fruit growing, promote better processing of Syrian fruits, and encourage government support of research and promotional work in fruit growing.

Willis E. Pequegnat, assistant professor, and head, Department of Zoology, Pomona College, has been promoted to associate professor.

Curt Stern, professor of zoology, and chairman, Department of Zoology, University of Rochester, has been appointed professor of zoology at the University of California, Berkeley. He will assume his duties there in the fall.

Frank Kerekes, professor, Department of Civil Engineering, Iowa State College Engineering Experiment Station, has been appointed assistant dean of the Division of Engineering. **J. D. Ryder,** Department of Electrical Engineering, has been appointed assistant director of the Engineering Experiment Station.

Frank T. Knapp, University of Toronto, has been appointed assistant in the Limnological Research Program, Cranbrook Institute of Science, Bloomfield Hills, Michigan.

E. Richard Dichter, consultant, Schenley Distilling Corporation, and formerly special assistant to the vice-president in charge of research and development, General Foods Corporation, has been appointed to the staff of Schering Corporation.

E. Lucy Braun, professor of plant ecology, University of Cincinnati Graduate School of Arts and Sciences, is leading a party of scientists from eastern United States and Canada into remote sections of the Kentucky mountains to study fast-disappearing virgin forest tracts there. The 5-day field expedition, centering near Pineville, in southeastern Kentucky, and sponsored by the Ecological Society of America, started June 9 from Clear Creek, Kentucky, for daily excursions to Kentucky Ridge Forest on Pine and Log Mountains, Natural Bridge, and the Red River Gorge.

Herbert E. Wright, Jr., Brown University, has been appointed assistant professor of geomorphology, Department of Geology, University of Minnesota. Dr. Wright will assume his new duties there in September.

Forrest F. Cleveland, chairman, Department of Physics and Mathematics, Lynchburg College, Lynchburg, Virginia, will be visiting professor of physics at Ohio State University during the summer semester, and will return in September to his former position as professor of physics, Illinois Institute of Technology, Chicago.

Henricus J. Stander, professor and head, Department of Obstetrics and Gynecology, New York Hospital, will receive the degree of Doctor in Medicine, *honoris causa*, from Trinity College, Dublin, Eire, at the Commencement Exercises of the College on July 2. While in Dublin, Dr. Stander will speak at the International Congress of Obstetricians and Gynecologists, to be held July 7–11.

Visitors to U. S.

Sir Edward Mellanby, secretary-director of the British Medical Research Council, who recently completed a visiting lectureship appointment at Vanderbilt University, spoke at the auditorium of the Children's Fund of Michigan, Detroit, on May 7 and at the Yale University Medical School on May 19 on "Nutrition in Relation to Bone Growth and the Nervous System." Sir Edward and Mrs. Mellanby took passage for England shortly thereafter.

Georg v. Békésy has been granted leave of absence by the Pázmány Péter University, Budapest, to spend a year on the staff of the Psycho-Acoustic Laboratory, Harvard University. Prof. Békésy is internationally known for his work in physiological acoustics, especially his investigations of the dynamics of the auditory mechanism.

Douglas H. K. Lee, professor of physiology, University of Queensland, Brisbane, Australia, will be in Washington, D. C., from June through September making a survey of animal climatology with Ralph W. Phillips for the UN's Food and Agriculture Organization. On October 1 Dr. Lee will join the staff at Johns Hopkins University, Baltimore,

where he will spend four months working on human climatology.

Jacques Maton, who recently received his doctorate from the University of Ghent, is studying phases of plant nutrition at the University of California, Berkeley, on a Belgian-American Research Foundation fellowship.

Grants and Awards

The Association for the Study of internal Secretions has recently announced the following awards: the Squibb Award for 1947, to Carl F. and Gerty T. Cori, Washington University, St. Louis, for their outstanding contributions on the role of the hormones in metabolism; the Ciba Award, to Choh Hao Li, University of California, for his significant contributions in the separation and study of hormones of protein nature and the isolation of the growth and adrenocorticotropic hormones in homogeneous and highly purified form; the Ayerst, McKenna and Harrison Fellowship, to Samuel Dvoskin, Columbia University, to enable him to continue his studies on the thyroid gland and thyroid hormone assays at Columbia under the direction of Robert Loeb.

Syracuse University has announced the establishment of two fellowships in organic chemistry by the Bristol Laboratories, Inc. The two Bristol Fellows recently appointed are John L. Biester and Robert C. Scott, who are working toward the Ph.D. degree under the direction of P. M. Ruoff, associate professor of chemistry.

Colleges and Universities

Carnegie Institute of Technology has received additional financial support for its 200,000,000-volt synchrocyclotron project in the form of a contract from the U. S. Office of Naval Research and an offer of equipment at special prices from the Westinghouse Electric Corporation. The total value of these two contributions is $280,000, or enough to fulfill the conditions of the $300,000 appropriation received by Carnegie Tech from the Buhl Foundation of Pittsburgh last December. The Foundation stipulated that its grant be supplemented by subscription of at least $250,000 toward the cyclotron from other sources.

Robert E. Doherty, president of the Carnegie Institute, expressed the hope that between $350,000 and $420,000 more may be raised so that Carnegie may build a synchrocyclotron having 130-inch magnet poles, instead of the 110-inch size projected last year. Total cost of the larger machine may reach $1,000,000.

Yale University has established the Ross Granville Harrison professorship in experimental zoology, named in honor of Ross G. Harrison, professor emeritus, who joined the Yale faculty in 1907, according to an announcement by President Charles Seymour. Edgar J. Boell, professor of biology, has been appointed the first incumbent of the new chair. The appointment is effective July 1.

Elections

The Iowa Academy of Science, at its 59th annual meeting in Cedar Falls, Iowa, April 18–19, elected the following officers: J. Allen Baker, president; William Kadesch, vice-president; F. G. Brooks, editor; and Cornelius Gouwens, secretary-treasurer.

Nine sections of the Academy held sessions which were attended by about 350 and during which 101 papers were presented. A joint symposium was held with the Iowa Medical Society. The guest speaker of the Academy, A. C. Trowbridge, gave an address on "A Geological Expedition to Norway."

The Association of American Physicians, at the closing session of its 60th annual meeting, Atlantic City, May 7, elected the following officers for the coming year: A. H. Gordon, Montreal, president; Francis G. Blake, New Haven, Connecticut, vice-president; Walter Bauer, Boston, treasurer; Cecil J. Watson, Minneapolis, recorder; Henry M. Thomas, Jr., Baltimore, secretary; and Joseph T. Wearn, Cleveland, Ohio, councilor.

The American Oil Chemists' Society, at its 38th annual meeting in New Orleans, May 22, elected the following officers: Reid T. Milner, Northern Regional Research Laboratory, president; C. P. Long, Proctor and Gamble, first vice-president; E. M. James, Lever Brothers Company, second vice-president; V. C. Mehlenbacher, Swift and Company, third vice-president; L. B. Parsons, Lever Brothers Company, fourth vice-president in charge of the soap section of the Society; H. L. Roschen, Swift and Company, secretary; and J. J. Vollertson, Armour and Company, treasurer.

The New York State Geological Association, at its meeting in New York City, May 9, elected the following officers for the coming year: Nelson C. Dale, Hamilton College, president; and Robert H. Arndt, Hamilton College, secretary.

NRC News

The Prevention of Deterioration Center, Room 204, National Research Council, 2101 Constitution Avenue, N.W., Washington, D. C., now offers the "Prevention of Deterioration Abstracts" on a yearly subscription basis. The Abstracts are set up under the following headings: Electrical and electronic equipment; Finished assemblies; Fungicides; Lacquers, paints, and varnishes; Leather; Lubricants; Metals; Microorganisms; Optical instruments; Packaging; Paper; Plastics, resins, rubbers, and waxes; Storage; Textiles; and Wood. Abstracted items include journal articles, patents, specifications, unpublished reports prepared by various Army, Navy, and other governmental groups, and unpublished British, Australian, and Canadian reports.

There will be approximately 1,500 pages of the Abstracts per year. The individual Abstracts are in loose-leaf form, so that they may be arranged in the manner desired. However, all Abstracts classified under any one heading will be numbered consecutively throughout the calendar year.

The Abstracts may also include comments made by the personnel of the Prevention of Deterioration Center. The price, including two binders and index guides, is $37.50 per year (July 1–June 30). Back issues for 1946 will be supplied.

The Subcommittee on Ophthalmology, Division of Medical Sciences, met in executive session in Chicago on April 27. The meeting was devoted to a discussion of ophthalmological problems encountered in the military services. The Subcommittee is also taking an active interest in the establishment of a national

institution for the training and rehabilitation of the blind, fashioned after the famous St. Dunstan's School in England. A proposal has been made by the Subcommittee that the Federal Government take over the facilities of the Army's rehabilitation center at Avon, Connecticut, where outstanding work has been done with those blinded in the war.

The Subcommittee includes the following members: Alan C. Woods, chairman; Edwin Dunphy, Trygve Gundersen, Lawrence Post, Algernon B. Reese, and Derrick T. Vail.

Recent Deaths

E. Granville Crabtree, 65, urologist, New England Baptist Hospital and Beth Israel Hospital, died in Sharon, Vermont, May 30. Dr. Crabtree was president-elect of the American Urological Association.

Walter T. Garfield, 65, dermatologist and professor emeritus, Tufts College Medical School, died May 31 at the Boston City Hospital after a brief illness.

Charles A. Kofoid, 81, professor emeritus of zoology, and formerly chairman, Department of Zoology, University of California, Berkeley, died May 30.

Walter J. Crocker, 61, former professor of pathology and bacteriology at the Veterinary School, University of Pennsylvania, died May 14, in Philadelphia.

H. E. Wells, 73, professor emeritus of chemistry at Smith College, died May 24 in Hartford, Connecticut.

G. A. Millikan, 41, head of the Department of Physiology, Vanderbilt University, died May 26 in Spencer Tennessee, as a result of injuries received on a mountain-climbing trip.

Thomas T. Read, 67, Vinton professor emeritus of mining engineering, Columbia University School of Mines, died of a heart ailment at the White Plains Hospital, New York, May 29.

The reprint collection of the late S. O. Mast is available for donation, The collection consists of some 15,000 separates, mostly in the field of general physiology and covering the past 50 years. Since the collection is especially rich in papers in invertebrate behavior and protozoan physiology, it would be appropriate to make it available to the library of an institution or department specializing in such work, and particularly to one in a devastated European center. Donation to an individual will not be considered. Suggestions for the disposal of this collection will be gratefully received by Dr. John B. Buck, National Institute of Health, Bethesda 14, Maryland.

The California-at-Davis Chapter of Sigma Xi was installed on the Davis campus of the University of California May 10. Carl D. Anderson, president-elect of the National Society, was the installing officer. Officers of the new Chapter for 1947–1948 are: Tracy I. Storer, president; Coit A. Suneson, vice-president; and Harold G. Reiber, secretary.

The University of Pennsylvania Press intends to publish in the near future an annual, *Chymia*, each volume of which will consist of about a dozen articles in the field of the history of chemistry. Papers on a variety of subjects will be included, and publication may be in French, German, Spanish, Portuguese, Italian, and English. This publication, which is being sponsored by the Edgar F. Smith Memorial Collection at the University, will be under the direction of a board of American editors, with a large group of consulting editors of international prominence. Further information may be obtained from Eva V. Armstrong, Secretary of the Board of Editors, Edgar F. Smith Collection, Harrison Laboratory, University of Pennsylvania, Philadelphia 4.

The National Registry of Rare Chemicals, Armour Research Foundation, 35 West 33rd Street, Chicago 16, Illinois, lists the following wanted chemicals: trimethyl aluminum, cholinesterase, decamethylenediamine, 1,2,3,4,5,6-hexachlorocyclohexylpentachloroethane, p-(β-dimethylaminoethyl)phenol, methylphenylbarbituric acid, 3,4-dihydroxynorephedrine, stevioside, creatine phosphate, hexacosane, phenyldimethylphosphine, citronellic acid, cellotetraose, glyoxylic acid, corynanthine, dihydromyrcene, kephalin, d-quercitol, quebrachitol, and indoxyl potassium sulfate.

The Medicinal Division, American Chemical Society, will publish its first monograph early next year. The monograph will be a complete progress report on world-wide advances in medicinal research. C. M. Suter, associate research director, Sterling-Winthrop Research Institute, Rensselaer, New York, has been appointed editor-in-chief. Dr. Suter will be assisted by the following editorial board: Walter H. Hartung, professor of pharmaceutical chemistry, School of Pharmacy, University of Maryland, Baltimore; Richard Roblin, director of chemotherapeutic research, American Cyanamid Company, Stamford, Connecticut; Peter K. Knoefek, professor of pharmacology, University of Kentucky School of Medicine, Louisville; Edward F. Degering, professor of organic chemistry, Purdue University, Lafayette, Indiana; Maurice L. Moore, assistant director of research, Frederick Stearns & Company Division, Sterling Drug, Inc., and chairman of the Medicinal Division (*ex officio*); and L. A. Sweet, Parke, Davis & Company, secretary of the Medicinal Division (*ex officio*).

The Chicago Natural History Museum has announced the following appointments: Emmet R. Blake, associate curator of birds; Loren P. Woods, curator of fishes; John W. Winn, assistant curator of fishes; and John W. Moyer, chief of the new motion-picture division of the Museum.

Make Plans for—

Meteoritical Society, 10th meeting, June 18–19, San Diego, California.

American Association of Physics Teachers, June 18–21, University of Minnesota, Minneapolis.

American Physical Society, June 19–21, Montreal, Canada.

American Society of Agricultural Engineers, June 22–25, Philadelphia, Pennsylvania.

American Society for X-Ray and Electron Diffraction, June 23–25, Montreal, Canada.

American Association of Dental Schools, June 23–25, Chicago, Illinois.

American Dairy Science Association, June 24–26, Ontario, Canada.

COMMENTS
by Readers

Ever since Boveri discovered that the large end segments of the chromosomes of *Ascaris* are discarded in the somatic cell lineage while the chromosomes remain intact in the germ track, the phenomenon, chromatin diminution, has attracted the attention of cytologists. Chromatin diminution has since been found to occur in other nematodes and in Diptera (Cecidomyids, Sciara), the cytological details being different from case to case. Among the numerous explanations proposed (most recent one by von Ubisch), that most in line with modern conceptions is that the diminished chromosome parts must be "inert so far as the soma is concerned" (White).

A re-examination of the cytological facts, using the Feulgen technique, proves beyond doubt that the discarded chromosome ends consist of heterochromatin. The decisive fact is that this substance is condensed during synapsis into a large, deeply staining chromocenter which fills a considerable part of the nucleus and to which the chromatin strands are attached. In pachytene this chromocenter is broken up and again distributed as four heteropycnotic ends of the tetrads. Boveri's old figures show, though it could not be interpreted correctly at that time, that there is also heteropycnosis of the chromosome ends in telophase of the first division of the egg. The Feulgen technique confirms this in a most convincing manner. Later, at the time of diminution, the Feulgen stain reveals in early metaphase that almost all Feulgen positive material is accumulated in the chromosome ends to be discarded, while the middle parts of the collective chromosomes which break up into the small somatic chromosomes stain rather slightly. Thus, there can be no doubt of the heterochromatic nature of the diminution chromatin.

This fact allows us to advance an hypothesis on the meaning of diminution which is in accord with some modern views on heterochromatin (e.g. Darlington). Nematodes are cell-constant animals, as shown a long time ago by Goldschmidt, Jägerskjöld, and Martini. This means that somatic cells undergo only a small number of divisions, after which further growth is intracellular growth leading to a small number of giant cells in most organs. Only the sex cells retain the ability for almost unlimited division. This means, we think, that the heterochromatin is needed for continuous mitotic cell division. A detailed discussion including also the situation in Diptera, and the relation of the cytological facts to the genetics of heterochromatin, will be presented later with the detailed facts. (RICHARD B. GOLDSCHMIDT and TEH PING LIN, *Department of Zoology, University of California, Berkeley.*)

It was demonstrated by Guerra (*Science*, June 7, 1946, p. 686) that the activity of hyaluronidase *in vivo*, as measured by the area of spreading when injected into the skin of rabbits or human subjects, is inhibited by salicylate. However, when the activity of the enzyme was measured *in vitro* by the decrease of the viscosity of its substrate, hyaluronic acid, no inhibition was observed when salicylate was added to the system. This is in accord with the observation of Pike (*Science*, April 11, p. 391).

It was therefore concluded that the action of the salicylate might be due to a metabolite formed by the organism.

Gentisic acid (2.5-dihydroxybenzoic acid), which has been demonstrated by Kapp and Coburn to be a metabolite of salicylic acid (*J. biol. Chem.*, 1942, **145,** 549), shows no inhibition. However, the corresponding carboxy-p-benzoquinone, which was synthetized by us, shows strong inhibitory properties at a concentration of 2.5×10^{-3} M. A detailed report of this work will be published elsewhere. (JULIUS LOWENTHAL and ARTHUR GAGNON, *Department of Physiological Chemistry, University of Montreal.*)

That anurans may lay as few as one egg per season is well known (Noble *Biol. Amphib.*, 1931, 70; *Sminthillus* of Cuba), but the maximum number has been diversely stated.

The maximum produced by North American anurans is recorded by Dickerson (*Frog Book*, 1908, 3) as 12,000 (*Bufo americanus*), and by Wright and Wright (*Handb. Frogs Toads*, 1942, 8) as 20,000 (*Rana catesbiana*). These numbers are exceeded, however, in at least three North American species of toads: one *Bufo a. americanus* is known to have laid 20,309 eggs, and one *B. w. woodhousii* 25,644 (Smith *Amer. mid. Nat.*, 1934, **15,** 438, 452); and, as pointed out by Gadow (*Amphibia Reptiles*, 1923, 54), even these figures are exceeded by *B. americanus terrestris*, a specimen of which is recorded (Morgan. *Amer. Nat.*, 1891, **25,** 753) to have laid as many as 28,000.

The bullfrog itself is recorded by Cramer (*Bull. Fla. St. Dept. Agric.*, 1936, No. 56, 37) as laying at least 21,840 eggs (this number of tadpoles was hatched from one spawn). In Viosca's *Principles of bullfrog culture* (New Orleans: Southern Biological Supply Co., 1934) the eggs are said to number as many as 25,000, a figure also given in the Fish and Wildlife Service's pamphlet on "Frog culture and the frog industry" (Fishery Leaflet No. 102, 1944, 3).

It is not unreasonable to suppose that very large specimens of at least one of these species may lay as many as 30,000, which may be accepted as the maximum for anurans of North America (except possibly *B. horribilis*).

Even this number is known to be exceeded elsewhere by *B. marinus* (tropical America; a close relative of *B. horribilis*), which, according to Alipio de Miranda-Ribeiro (*Arch. Mus. Nac. Rio de Janeiro*, 1926, **27,** 134), produces approximately 32,000 at each spawning. No doubt this species may produce as many as 35,000 upon occasion. So far as I am aware no amphibian anywhere in the world is known to lay more than this number at one time.

It is also of interest to point out that, in proportion to body size, members of the genus *Bufo* are clearly more productive of eggs than any other anurans. (HOBART M. SMITH, *A. & M. College of Texas, College Station, Texas.*)

TECHNICAL PAPERS

Development of Streptomycin-resistant Variants of Meningococcus[1]

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In an attempt to explain the rapidity with which meningococci develop a very high degree of streptomycin resistance during two or three subcultivations on media containing increasing concentrations of the drug (*6*), the following observations were made.

A series of plates was prepared containing streptomycin[2] in graded concentrations from 10 to several thousand μg./ml. of media, and the surface of each was inoculated with a heavy seeding of meningococci. The inocula were carefully spread by means of small glass beads which were rolled back and forth and discarded after the inocula were evenly distributed. The plates were examined at the end of 24, 48, and 72 hours incubation. The results of a typical experiment are presented diagrammatically in Fig. 1.

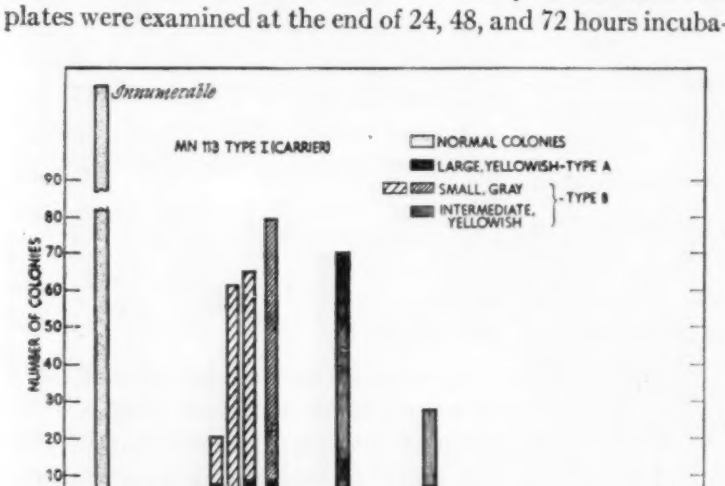

FIG. 1. Diagrammatic representation of colonies developing from equivalent inocula of meningococci on graded concentrations of streptomycin. Density in cross-hatching indicates differences in size and color of Type B colonies.

Normal meningococcus colonies developed on the lowest concentrations of streptomycin (10–20 μg./ml.) but were lacking on concentrations above 40 μg./ml. On concentrations higher than that, two types of colonies unlike the normal were observed. These have been designated variants A and B. Their properties are summarized in Table 1.

Both variants have developed from 16 of 18 strains of meningococcus and on all of 25 preparations of streptomycin, including several of a high degree of purity.

The type A variant appears in approximately equal numbers on all concentrations of the drug, but the numbers of colonies per plate vary considerably from strain to strain. It seems highly probable, therefore, that this type of colony arises from streptomycin-resistant mutants which are appearing regularly in the original bacterial population.[3] This variant differs from the original culture in size and color of colony and in being streptomycin resistant *in vitro* and *in vivo*. It multiplies on any medium which supports growth of normal meningococci. It is as virulent for mice as the original culture from which it arose, and produces infection against which maximal doses of streptomycin afford no protection.

TABLE 1

SUMMARY OF CHARACTERISTICS OF MENINGOCOCCUS VARIANTS A AND B

	Type A	Type B
Colonial appearance		
Size	Large on all concentions of streptomycin	Small on low concentrations; medium on higher concentrations
Color	Yellowish	Pearl gray on low concentrations; slightly yellowish on higher concentrations
Viability on all concentrations of streptomycin	Grows readily	Grows readily on concentrations above 5 μg.ml.
Viability on streptomycin-free media	Grows readily	No growth*
Virulence for mice	Fully virulent	Nonvirulent except in streptomycin-treated mice
Effect of streptomycin treatment on experimental infection in mice	No protection from maximal doses	Promotes development of fatal meningococcal sepsis

* Among many subcultures onto streptomycin-free media only 4 single colonies grew out slowly.

Variants presumably of the same sort have been described by Alexander and Leidy (*1*) from *Hemophilus influenzae* and by Chandler and Schoenbach (*5*) from other microorganisms.

Colonies of the type B variant have one characteristic in common: They all require streptomycin for reproduction *in vitro* and *in vivo*. This variant is not virulent for mice; *i.e.* intraperitoneal inoculations with mucin suspensions (*7*) failed to produce meningococcal infection. However, mice thus inoculated and treated with adequate doses of streptomycin (500–5,000 μg.) developed fatal meningococcal sepsis. Meningococci

[1] This investigation was supported jointly by the U. S. Navy, Office of Naval Research, and the University of Chicago. It also received assistance from the Antibiotic Study Section, Research Grants Division, U. S. Public Health Service, and from the A. B. Kuppenheimer Foundation of the University of Chicago.

A preliminary report of the study was presented at the Conference on Antibiotic Research held at Washington, D. C., on February 1, 1947 under the auspices of the Antibiotics Study Section, National Institute of Health.

[2] Preparations of streptomycin were supplied by the Antibiotics Study Section, National Institute of Health, U. S. Public Health Service; the Division of Penicillin Control and Immunology, Food and Drug Administration; Abbott Laboraties; Eli Lilly & Company; Merck & Company; Chas. Pfizer & Company; and E. R. Squibb & Son.

[3] The authors are indebted to Sewall Wright and Thomas Park, Department of Zoology, University of Chicago, for their helpful suggestions and criticisms of the genetic aspects of this problem.

could be recovered regularly from their hearts' blood in cultures made on streptomycin-containing media but not in duplicate cultures made on streptomycin-free media.

The results of these mouse inoculations indicate that (1) the type B variants are nonvirulent for (untreated) mice; (2) they require streptomycin for their reproduction *in vivo* as well as *in vitro*; and (3) their dependence on streptomycin for growth persists after multiplication within the body of an infected animal host.

The origin of the type B variant is difficult to explain except as current mutation. It never appeared on media containing less than 40 μg./ml., but once it had developed, it could be subcultured on concentrations as low as 5 μg./ml. It could not be grown on less even after repeated transfer on media containing that concentration. The rare occurrence of a single colony on streptomycin-free media represents an exception to the rule and seems most likely to be the result of mutation back to normal.

The numbers of colonies developing from equivalent inocula are always greatest on concentrations between 100 and 400 μg./ml., whether the seedings are made from a parent (stock) strain, as illustrated in Fig. 1, or from a subculture of type B variant taken from a high or a low concentration of streptomycin. This fact seems to indicate that all the B variants are alike genetically and that the higher reproductive rate at those concentrations reflects a physiological response to the drug rather than a differential induction of the variants at different concentrations.

The variation in color and size of their colonies in relation to the concentration of the drug is additional evidence that streptomycin directly affects the physiology of the bacterial cells. On 60–100 μg./ml. they are small and pearl gray. On higher concentrations, they develop greater size and acquire a distinctly yellowish tinge, resembling the large variants described as type A. Small, gray colonies taken from low concentrations and transferred onto higher concentrations grow as medium-sized, pigmented colonies. Conversely, pigmented colonies taken from high and subcultured onto low concentrations develop as small gray colonies.

Benham (*4*) has noted the stimulating action of streptomycin on the O_2 uptake of typhoid bacilli. Welch, Price, and Randall (*9*) report that small doses of streptomycin increased the mortality rate of mice infected with typhoid bacilli.

Studies on the growth requirements of mutants isolated from cultures of *Bacillus coli* after treatment with bacteriophage (*2*) or X-ray (*8*) have demonstrated a variety of deficiencies in their metabolic processes. Similar observations have been made on mutants induced in *Neurospora* by X-ray (*3*).

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Irritating Effects of 9,9-Dibromofluorene

John R. Sampey, Anne B. King, Thomas A. Roe, Jr., and S. J. Childress[1]

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Alfred Cavendish (*1*) has reported the irritating effects of 9-bromofluorene. In the further study of the photochemical bromination of fluorene (*2*), one of us (A. B. K.) worked several weeks with 9-bromofluorene without any irritation, but on the first exposure to 9,9-dibromofluorene, a severe skin eruption developed.

The irritation set in shortly after crystallization of a sample of 9,9-dibromofluorene from hot glacial acetic acid. Red blotches appeared first on the back of the left hand and the inner left wrist, and after a few hours red streaks developed on the face and ear. The rash spread gradually, and after three weeks it covered both forearms and face completely, and one eye was swollen shut.

Administration of benadryl relieved the severe itching at once, and within a few days the face peeled, and the blotches on the hands and arms began to dry up. Six weeks from the time of exposure, small red blotches remain only at the points of initial contact.

A second member of the group suffered some inflammation and itching of the hands following one exposure to 9,9-dibromofluorene, but the condition cleared up within a week, without medical attention.

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dl-α-Amino-ε-Hydroxy Caproic Acid in the Rat

R. Gingras, Edouard Pagé, and Roger Gaudry

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In the course of the synthesis of lysine from dihydropyran, one of the authors (R. Gaudry) prepared dl-α-amino-ε-hydroxy caproic acid by hydrolysis of 5-δ-hydroxy butyl hydantoin. Since this amino acid differs from lysine only because of its hydroxyl group instead of the ε-amino group, it was thought of interest to investigate its biological properties.

Young albino rats averaging 66 grams in weight were first placed on a diet of the following percentage composition: zein, 10; dl-tryptophane, 0.2; cellu-flour, 2; soybean oil, 4; salt mixture, 4; sucrose, 79.65; choline chloride, 0.15. Each 100 grams of ration contained: thiamine-HCl, 0.4; riboflavin, 0.4; pyridoxine-HCl, 0.5; calcium pantothenate, 3.0; nicotinic acid, 3.0; inositol, 10.0; and 2-methyl-1,4-naphthoquinone, 0.1 mg.

After 24 days on this diet, weight changes were very small (Table 1), and the following additions were made to the ration at the expense of the sucrose: Group I (Zt), 0.6 per cent zein; Group II (Ztl), 0.6 per cent l-lysine; and Group III (Ztl-OH), 1.5 per cent dl-α-amino-ε-hydroxy caproic acid. Eleven days

[1] Acknowledgment is made of a grant from the Carnegie Foundation for the Advancement of Teaching.

later, the rats on the lysine-deficient ration had shown a slight weight loss, while those receiving l-lysine were gaining weight. The largest weight losses were recorded by the rats receiving the synthetic racemic compound (Table 1). One of the rats in this group died on the 11th day, and the experiment was discontinued. The animals were sacrificed and the kidneys were dissected and weighed. Kidneys of rats receiving the α-amino-ε-hydroxy caproic acid were slightly heavier, but histological examination[1] failed to reveal any differences between groups.

TABLE 1

WEIGHT CHANGES (GRAMS) IN RATS RECEIVING α-AMINO-ε-HYDROXY CAPROIC ACID AND IN CONTROL GROUPS

	Zt	Ztl	Ztl-OH
No. of rats per group	4	6	6
Wt. changes during last 10 days of preliminary period (24 days)	−4	−3	−2
Range	−3, −6	−1, −4	−2, −3
Wt. changes during experimental period (11 days)	−2	+5	−8
Range	−1, −3	+2, +9	−6, −10

It is concluded that α-amino-ε-hydroxy caproic acid cannot replace lysine in the diet and that it may have some toxic effect.

[1] Kindly done by C. Auger, of the Pathology Department.

Mechanism of Renin Tachyphylaxis—Restoration of Responsiveness by Tetraethyl Ammonium Ion

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The pressor responses to repeated intravenous injections of renin in intact animals diminish progressively. This phenomenon is known as tachyphylaxis. The action of renin is dependent on the presence of plasma renin-substrate, the exhaustion of which might account for tachyphylaxis. But administration of large amounts of α_2 globulin, the fraction of plasma protein containing substrate, does restore the response in tachyphylactic animals (*6*).

Renin through its effector agent, angiotonin, acts directly on peripheral blood vessels. Nevertheless, sectioning of the brain at certain levels causes the pressor response to be reversed to depressor (*3*), a phenomenon which has been further localized by Euler and Sjöstrand (*2*). Widespread direct injury to the central nervous system also temporarily abolishes the pressor response to angiotonin (*4*), as does severe shock produced by a variety of means (*5*). Thus, the nervous system influences vascular responsiveness to angiotonin.

One of the difficulties of accepting the renal-vasopressor system as a cause of renal hypertension has been the phenomenon of renin tachyphylaxis.

Acheson and Pereira have shown that injection of tetraethyl ammonium chloride (*1*) blocks sympathetic ganglia. We have found that repeated (1–4 times) intravenous injections of 100 mg. into normal dogs anesthetized with pentobarbital completely overcame tachyphylaxis induced by repeated injection of renin. The response to angiotonin itself was also augmented. Even more striking was the manyfold increase in the response to adrenalin at a time when the response to nicotine was wholly abolished. The responses to histamine, mecholyl, and barium chloride were usually also augmented. Without anesthesia the same phenomena occur, but to a lesser degree. Adrenalectomy or nephrectomy in brief experiments did not alter these responses.

If the caudal spinal cord was destroyed after section at C_1 and the animal tested the next day after complete recovery from anesthesia, the responses to renin were augmented. Further, 8 injections of renin did not lead to appreciable tachyphylaxis. Administration of tetraethyl ammonium ion now did not further augment the already large response.

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Absence of a Macrocytic Anemia in Dogs Fed Choline or Choline Plus Fat

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Several groups of investigators in this university have been interested in choline since this substance was established as a dietary factor by the work of Best and Huntsman (*1*). While no detailed study of the effect of choline on the blood picture had been made here, a number of hemoglobin and red cell estimations in dogs fed large amounts of choline had failed to reveal any signs of anemia. A series of papers by Davis (*2*), in which it was reported that the administration of choline or choline plus fat produced in dogs a macrocytic anemia, came, therefore, as a surprise. An additional stimulus to the investigation of Davis' claims was provided by the fact that choline or its precursor, methionine, is now being used in many clinics in an effort to determine its role in the prevention of fat deposition or cirrhotic changes in the liver of patients.

A series of four normal male dogs was carefully observed by one of us (M. F. C.), and after the somewhat extended period necessary to obtain satisfactorily constant basal values for the red cell counts and the hemoglobin levels, choline or choline plus fat was added to the stock diet of the animals, which consisted of Canada Packers Frozen Dog Chum, sucrose, and bone meal. Dried yeast and cod-liver oil were provided twice each week and tomato juice once a week. All four dogs were on this diet for at least three months before the feeding of choline or choline plus fat. During this period they all gained weight, and their coats improved in texture.

For two of the dogs 10 mg. of choline/kg. of body weight and 60 grams of lard were added to the stock diet. The daily ration was fed at one meal, and the choline was incorporated in the center of a small portion of meat and offered to the dogs before the balance of the meal was given. In this way it was made certain that the dogs ingested all of the choline offered. Both animals ate their fatty meals well for the first week and then refused to eat all of the food. The fat and choline were discontinued after the eighth day. Davis reports an anemia on the second and third day under these dietary conditions.

For the second pair of dogs the daily ration of the stock diet was divided into three equal feedings, and with each feeding 10 mg. of choline/kg. of body weight was administered in the same manner as previously described.

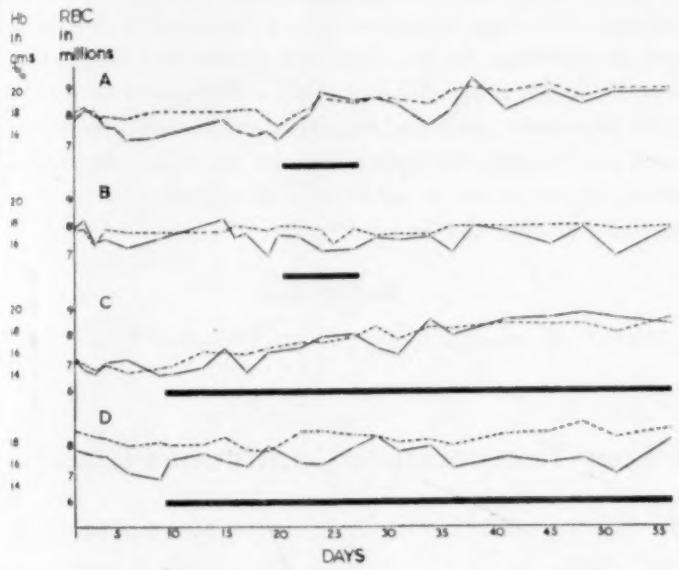

FIG. 1. Red cell counts and hemoglobin levels as influenced by choline or choline plus fat feedings. Solid lines represent red cell counts; broken lines, hemoglobin level; and solid black bars, the periods of choline or choline plus fat feeding. A and B were fed choline plus fat; C and D were fed choline three times a day.

The findings are illustrated in Fig. 1. It will be observed that we failed completely to confirm Davis' finding that a macrocytic anemia is produced in dogs when choline or choline plus fat is administered. In two dogs, A and C, there was an increase in the hemoglobin level and in the erythrocyte number. We do not ascribe this increase to the choline or choline plus fat, but strongly suspect that the rise is produced by a continued administration to the animals of a diet more adequate in the various hemopoietic factors than that which they had previously received. If Davis' results are confirmed under dietary conditions differing from those followed in our laboratory, the nature of the stock diet should be closely examined to determine the part it plays in the production of the findings. As estimated in this laboratory, Purina Dog Chow Checkers, of which Davis' stock diet is composed, contains 1.5 mg. choline/gram, and the Canada Packers Frozen Dog Chum contains 1.04 mg./gram. Our dogs received in the stock diet approximately 429 mg. of choline daily. We have found that they will not eat more than 180 grams of the Purina Chow daily. Consequently, they may have received about 160 mg. more choline/day in their stock diets than Davis' dogs.

In another group of four normal male dogs 10 mg. of choline/kg. of body weight was fed in dilute solution by stomach tube once a day, before the stock diet supplemented with 60 grams of lard was offered. During the eight days of the experiment there was no evidence of a macrocytic anemia.

An analysis of nurses' diets used in one of the large hospitals in Toronto showed that up to 500 mg. of choline may be available in a normal diet each day. This amount is presumably supplemented by choline arising from its precursor, methionine, which is supplied by the protein of the diet. There is, of course, no indication that normal diets, most of which provide appreciable amounts of choline, play any role in the production of an anemia.

Our results permit us to state quite definitely that, under the conditions of our experiment, the addition to stock diets of the amounts of choline or choline plus fat recommended by Davis does not produce in dogs any trace of a macrocytic anemia. It is apparent, therefore, that the acceptance of Davis' general conclusions cannot be justified and that further work is necessary to determine the explanation of his findings.

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IN THE LABORATORY

An Automatic Recording Siphon

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An experimental study (*1*) required simultaneous records of intralumen pressures in, and flow through, Thiry-Vella loops in dogs. The pressures were recorded photokymographically, using modified Frank capsules as tambours, and flow was similarly recorded by means of the automatic siphon devised by the author for this purpose.

Since the use of optical manometers is rapidly gaining favor among investigators interested in studies involving accurate measurement of pressures and flow, it is felt that a brief description of this siphon may be helpful.

The siphon (Fig. 1) is constructed of pyrex glass, utilizing a test tube of convenient size and sections of tubing and reinforcing rod, and can be readily made by anyone able to weld pyrex tubing.

The fluid to be measured enters the receiving chamber, B, at A and continues to fill the system until the level reaches f,

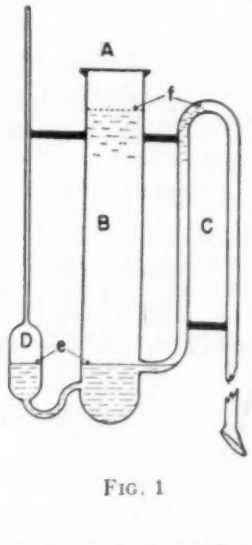

FIG. 1

when the fluid escapes through the siphon arm, C. The system empties until the fluid level reaches e and air enters the siphon arm. With the fluid level at e, the side chamber, D, is connected by rubber tubing to an optical manometer. Subsequent additions of fluid to B cause increased pressure in D which is transmitted to a sensitive manometer and recorded photokymographically in such a way as to give a rising line which falls suddenly each time the siphon empties. Rate of flow is shown by the slope of the line at any point, and total flow is indicated by the change in height between any two points (plus the volume of the siphon multiplied by the number of times it has emptied in the meantime). The manometer can be accurately calibrated by adding known increments of fluid to B and taking short strips of record. The size of chamber B can be adjusted to the investigator's needs. The size of chamber D should be such that there is little variation in the level of fluid. The internal diameter of the siphon tube, C, however, is critical. If it is too great, there is a tendency for fluid to spill over without emptying the system; if it is too small, a column of air bubbles and fluid is retained in the right-hand limb, and the system empties before fluid reaches level f. With water, the best operation was obtained with a siphon arm 5–6 mm. in internal diameter. In addition, the siphon arm empties itself more efficiently if one end of a small string is tied to one of the upper supporting rods and the other end passed into chamber B and out through the siphon arm, its function being to aid in preventing retention of bubbles in the siphon arm after each emptying of chamber B.

Reference

1. LIGON, E. WILLIAM, JR. *Proc. Soc. exp. Biol Med.*, 1943, **52**, 282-284.

A Low-Temperature Continuous Extractor[1]

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When extracting proteins and other organic materials with organic solvents it is often necessary to carry out the extractions at reduced temperatures to avoid denaturing or destroying them. This is usually done in flasks, necessitating large volumes of solvent and much handling. An extractor requiring relatively small amounts of solvent, very little handling of the material being extracted, and with safeguards protecting the solvent from absorbing water is described (Fig. 1).

The material to be extracted is placed in a thimble, H (43 x 123 mm.), which is then inserted in the vacuum-jacketed extraction chamber, F. The solvent is placed in the round-bottomed flask, I (1 l.), and some is also placed in the trap. On boiling the solvent, the vapor rises up the glass column, is condensed in the bulb condenser, passes through the cooling coil, C (8-mm. tubing), into the extraction chamber, and then siphons off and returns to the flask.

Cooling is achieved by the bulb condenser and the cooling coil. When using solvents with high boiling points, ice water can be circulated through the condenser, but with those such as acetone and ether, the temperature of the tap water suffices. A solvent such as acetone is circulated in the jacket, G (35 x 8 cm.), surrounding the cooling coil, and is cooled by passing through a copper coil, B, immersed in a Dewar flask containing a cooling medium such as CO_2-acetone. The acetone enters the

[1] The work during which this development occurred is supported by a grant from the Rockefeller Foundation.

bottom of the jacket and leaves by way of the glass tube suspended in the center of the cooling coil. By using CO_2-acetone as a coolant, temperatures as low as −65°C. can be maintained in the extraction chamber.

The temperature can be controlled by empirically determining the temperature in the CO_2-acetone bath necessary to keep the extraction chamber at the desired level or, more easily, by a thermoregulator, D. The thermoregulator used in this laboratory is of the type commonly employed in commercial refrigeration. It controls the circulating pump, E, and with the CO_2-acetone in the Dewar kept from 20°–30°C. lower

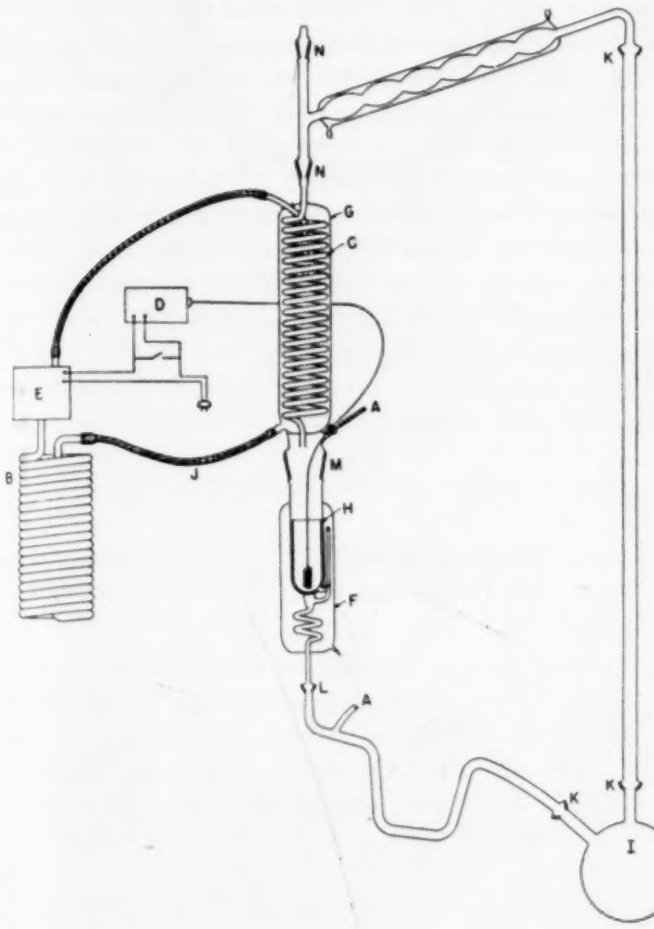

FIG. 1

than that desired in the extraction chamber, the temperature can be maintained within ±1° C. down to −20°C. For lower temperatures the thermoregulator is shorted out, and the pump runs independently of it.

The temperature in the extraction chamber is obtained by placing a thermometer outside the thimble and observing it through the walls of the chamber. A thermocouple may be inserted through the same opening at which the thermoregulator enters.

Openings to the atmosphere, provided at A, are connected to $CaCl_2$ tubes. Ball and socket joints, K (28/15) and L (18/9), permit easy handling and prevent strains in the setup; the other joints, N (19/38) and M (60/50), are standard taper. Rubber tubing, J, connects the copper coil with the cooling jacket.

The apparatus lends itself readily to successive extractions with different solvents merely by changing the solvent in the flask and trap. The residual solvent in the extraction chamber is removed by applying suction to the outlet of the extraction chamber, L.

An Alternate Method of Cleaning Mercury

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The classical operation of squeezing mercury through a chamois often leads to extensive spilling unless a mercury press is used. A simple and thoroughly satisfactory alternative method utilizes nothing more than vacuum filtration in place of squeezing through the chamois. The schematic arrangement is shown in Fig. 1.

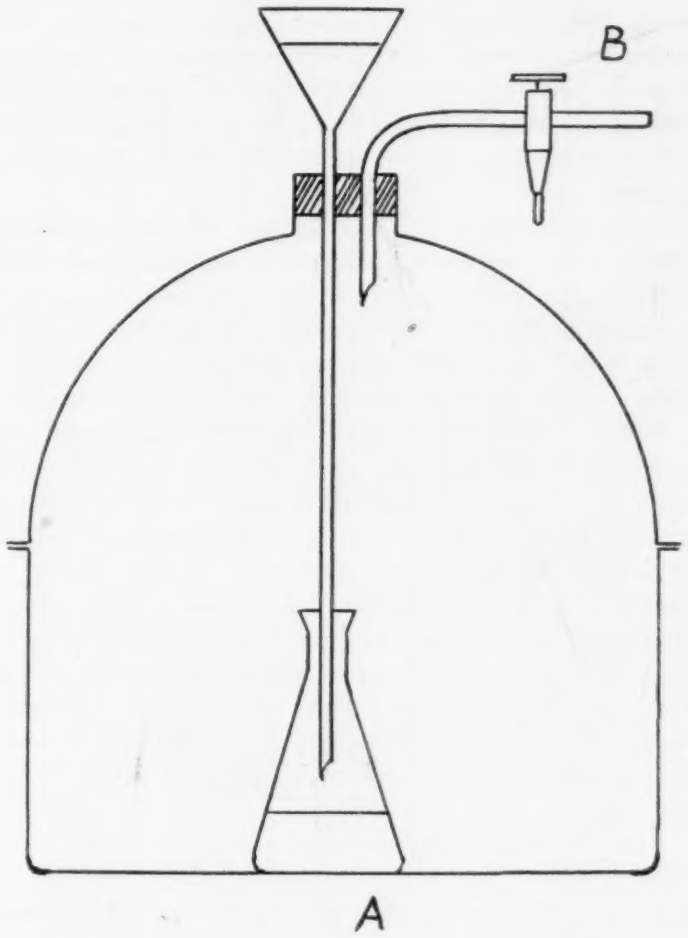

FIG. 1

The vessel, A, is a Pyrex low-vacuum distilling apparatus, and B is a three-way stopcock with an outlet through the plug. In operation, a 2-inch, long-stem funnel requiring only a 4-inch square of chamois will filter, on house vacuum (ca. 25–35 mm.), 5 pounds of mercury within a few minutes. As a receiver, a 500-ml. Erlenmeyer flask will hold splattering down to a minimum. The weight of the mercury and the effect of the suction are sufficient to hold the chamois snugly against the funnel so that air does not leak between the funnel wall and chamois.

When cleaned mercury is to be used immediately, a filter flask of the appropriate size can be substituted for the receiver and vacuum chamber. When, however, it is desired to catch the mercury directly in a cleaned container for storage, the vacuum chamber is preferred, permitting the use of almost any size and shape of container. The container may be removed, stoppered, and put away without again handling the filtered mercury.

This method has been used by the author over a period of time with excellent results in rapidity of filtering; in cleanliness of mercury, and in minimum of loss.

Book Reviews

Electrons* (+ *and* −), *protons, photons, neutrons, mesotrons, and cosmic rays. (Rev. ed.) Robert A. Millikan. Chicago: Univ. Chicago Press, 1947. Pp. x + 642. (Illustrated.) $6.00.

Robert A. Millikan's new book on the electrons and other particles of modern physics is not so much a revision of the earlier editions as a reprinting with a supplement. The first 10 chapters are almost identical with the 1924 revision of the original book, called *The electron*, which was published in 1917. The next 5 chapters were added in the 1935 edition, and the last 5 are new.

As is explained in the Introduction, the book is devoted mainly to the researches of Millikan himself and his associates. However, the background and theoretical implications of the experiments are given in such detail, and Millikan's work has involved so many fields of physics, that the book amounts to a fairly complete review of atomic physics in the 20th Century.

It begins with the history of the atomistic concept of electricity, which culminates in Millikan's famous oil-drop experiment to measure the electronic charge. Following this, the problem of the nature of radiant energy provides background for Millikan's photoelectric experiments, which verified the crucial Einstein equation. Then the experiments of Bowen and Millikan in spectroscopy shed new light on the structure of atoms and led to the discovery of the spin of the electron. Finally we come to the work of Millikan and his associates on cosmic rays and nuclear physics—work which has been responsible for much of our present-day understanding of these subjects.

The new chapters may be summarized briefly as follows: One chapter explains how nuclear energy is released and discusses the practicality of commercial use of nuclear energy as a source of power. It seems to this reviewer that the chapter is not very well written or very scientific in the manner of drawing political, economic, and social conclusions from incomplete data.

A second chapter summarizes in detail the geomagnetic studies of cosmic rays made by Millikan, Bowen, and Neher in the years 1920–36. An explanation is also given of Millikan and Cameron's failure, in 1926, in their first effort to find a geomagnetic effect.

The third of the new chapters relates the history of the discovery of the mesotron and describes the properties of this particle. It is shown how the existence of such a particle was indicated by the high-altitude surveys made by Millikan, Bowen, and Neher and conclusively proved by the cloud-chamber data of Anderson and Neddermeyer.

The last two chapters are devoted to the nature of the primary cosmic rays and particularly to Millikan's hypothesis concerning the origin of these rays through the process of annihilation of atoms in interstellar space.

Any reader of the book who is not a learned physicist should be warned of the following: (1) Although the early chapters have been touched up slightly in an effort to modernize them, the effort has not been completely successful. Thus, the picture of the atom and its nucleus presented by Millikan in Chapter IX is definitely a 1924 painting with a few daubs of 1935 and 1946 paint; a 1946 picture would be somewhat different. Similarly, the first chapters on cosmic rays constitute a 1935 picture. (2) Over the years between editions of this book, common usage has changed with regard to the meanings of a few of the words. As a result, Millikan's book is not entirely consistent in word meanings, either within itself or as compared with other modern texts. For instance, his "positive electrons" may be either protons or positrons, and his "fast electrons" may be mesotrons or high-energy protons, positrons, or electrons. (3) Not all of the declarations made by Millikan meet with agreement among other prominent and competent physicists. In particular, many physicists feel that the evidence in favor of Millikan's hypothesis regarding the origin of cosmic rays is not as strong as one would gather from the book. (4) As a survey of modern physics, the book is far from impartial. The scientific world here presented has its center obviously in the Norman Bridge Laboratory at the California Institute of Technology.

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Bioelectric fields and growth. E. J. Lund and collaborators. Austin, Texas: Univ. Texas Press, 1947. Pp. vii+391. Illustrated.) $6.00.

This important experimental contribution to the literature of biophysics supports the senior author's thesis that continuous, self-generated electrical fields operate as primary correlating mechanisms in living systems lacking nervous and circulatory devices, e.g. in the control of embryonic growth pattern.

About one-fifth of the space is devoted to the effects of externally applied electric fields upon polar growth in the onion root, *Avena* coleoptile, and reassociated cell masses of *Obelia*. The remainder is concerned with (1) measurement of the distribution of potential differences in space and time and in relation to environmental factors in *Pithophora* (a linear cell aggregate), the mantle of *Anadonta* and *Unio*, the onion root, and the coleoptile of *Avena*; (2) the counter-EMF developed in the onion root by applied currents in relation to intensity, duration and direction of current, region of the root, and effects of oxygen and cyanide; and (3) the capacity of frog's skin to perform electrical work and the efficiency of the process. The importance of these last three types of data cannot be overemphasized, for understanding of the control exerted by external electric fields rests upon knowledge of their effects upon the fundamental physiological properties of the growing systems. Extrapolation of such knowledge to the morphogenetic fields operating in normal development demands, in addition, complete information of the spatial and temporal distribution of the self-generated electrical potentials and the patterns and limits of internal electrical energy expenditure.

A valuable addition is the beautifully cross-indexed bibliography of 1406 titles on continuous bioelectric currents and bioelectric fields, by H. F. Rosene.

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